Report as of FY2009 for 2009ND186B: "Development of GAC-NZVI Adsorbent for Arsenic Removal"

Publications

- Conference Proceedings:
  - Chang, Q.G. and Lin, W. (2009) Development of GAC-Fe to remove arsenic from water. Proc. of the 82nd WEFTEC, Orlando, USA, 1552-1571.
  - Chang Q. G. (2009) ND EPSCoR 2009 State Conference. Preparation of iron impregnated granular activated carbon for removing of arsenic from groundwater , NDSU, Fargo, September 24, 2009

Report Follows

Synthesis of GAC-Fe

In 2008, a new iron impregnation method was developed and GAC-Fe adsorbents with different iron contents were synthesized. Scanning Electron Microscope (SEM), Energy Dispersive X-Ray Scope (EDS), and X-Ray Diffraction (XRD) were used to characterize GAC-Fe adsorbents in terms of distribution, morphology, and species of iron. Three different methods were compared as to measure the iron contents of GAC-Fe adsorbents.

In 2009, this impregnation method was modified to improve the impregnating efficiency, the stability of iron, and the arsenic adsorption capacity of GAC-Fe adsorbent. The synthesis of GAC-Fe adsorbents using the modified method was finished in the summer 2009 and 11 different GAC-Fe adsorbents were obtained. With a stabilizing step included in each repetition of the synthesizing process rather than at the end of the entire synthesis, iron is more stable in GAC-Fe and iron impregnation efficiency is improved. The results demonstrated that the modified method is about 2 times efficient in terms of the amount of iron impregnated in GAC than the original one. More than 28% of iron was impregnated inside GAC Darco 20×50.

Analytical methods for arsenic

In 2008, the arsenic analytical method was established using Inductively Coupled Plasma (ICP) at the Department of Biological Sciences, NDSU. ICP has the advantage to analyze multi-elements simultaneously; however, the detection limit (30 ppb) of ICP is too higher to conduct research close to the arsenic standard (10 ppb) for drinking water. Alternative analytical method is needed to carry experiments out at low arsenic concentration range (<10 ppb).

In 2009, Fargo Water Treatment Plant donated a Graphite Furnace Atomic Absorption Spectrometer (GFAAS) to the Environmental Engineering Lab at Department of Civil Engineering, NDSU. I spent three months on setting up and making the instrument functional. Currently, this GFAAS is updated with new part, calibrated and working well. It has a detection limit of 1ppb on arsenic.

Arsenic adsorption study

Since 2008, arsenic adsorption tests were carried out to measure adsorption capacity of the GAC-Fe. To keep conditions close to the drinking water treatment, the pH of adsorption tests was controlled around neutral using 0.05N bicarbonate buffer solution. It was found that GAC-Fe adsorbents have high affinity to arsenate and GAC-Fe adsorbent with 4.22% performed the best among 5 GAC-Fe adsorbents.

In 2009, more arsenic adsorption tests were conducted to identify the relationships among iron content, arsenic adsorption capacity, and iron efficiency of GAC-Fe adsorbents. In addition, the impacts of pH and reaction time on adsorption capacity were investigated. GAC-Fe adsorbents exhibit high level removal rate of arsenic at pH range 5-7.5 and low removal rate at pH above 8.

Langmuir Model was used to interpret the arsenic adsorption behavior of GAC-Fe adsorbents in this research. Different from the conventional way to estimate parameters in Langmuir model, nonlinear regression (rather than linear regression) was employed to estimate these parameters. The nonlinear regression procedure was coded using Statistical Analysis System (SAS). Results indicated that nonlinear regression fits isotherm curves much better than linear regression, because there is a serious transformation bias in the linearization of Langmuir model.

Currently, with the aid of GFAAS, a series of isotherm tests is in the process to determine the arsenic adsorption capacity of the 11 new GAC-Fe adsorbents, synthesized using the modified impregnation method, at a low arsenic concentration window (1-200ppb). The results will discover the new relationship relationships among iron content, arsenic adsorption capacity, and iron efficiency of GAC-Fe adsorbents. Available data showed a promising sign that the new GAC-Fe adsorbents exhibit enhanced arsenic adsorption capacity.